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**APPLICATION FOR UNITED STATES LETTERS PATENT**

**for**

# CONNECTOR MODULE HAVING REDUCED INSERTION FORCE

**by**

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# CONNECTOR MODULE HAVING REDUCED INSERTION FORCE

## TECHNICAL FIELD

**[0001]** The present invention generally relates to medical devices, and in particular to a device connector module assembly.

## BACKGROUND

**[0002]** Implantable medical devices (IMDs) typically include connector modules for the coupling of implantable medical leads to the devices; the medical leads include elongated bodies extending from a proximal connector and carrying conductors for delivery of therapy from the IMD to a selected site within a body of a patient. One type of therapy most commonly delivered through such leads is electrical stimulation therapy; therefore electrical contacts are formed on the lead connector to make electrical connection, within the connector module, between the conductors of the lead and the IMD. It should be noted that leads and devices may also be implanted solely for the purpose of diagnostic monitoring, wherein electrical contacts are also elements of the lead connector, or for the purpose of therapeutic agent infusion, wherein electrical contacts are not required elements. For the purposes of this application, reference will be made only to a pacemaker IMD and lead, it being understood that the principles herein may have applicability to a host of other medical systems.

**[0003]** Once a cardiac lead has been implanted such that one or more electrodes are in contact with cardiac tissue, the connector of the lead is inserted into an IMD connector module bore containing one or more electrical connectors that are configured to engage with one or more contacts located on the lead connector. Both electrical and fluid tight seals are required between each electrical contact and between the lead connector, within the bore, and the implant environment outside the bore. Sealing rings, mounted either on the lead connector or within the bore, create such seals, however it has been found that the seals may make full insertion of the lead connector difficult due to pressure build-up within the bore once a first set of sealing

rings engages between the lead connector and the bore. Accordingly, there is a need for a device connector module assembly that relieves or vents this pressure.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0004]** The following drawings are illustrative of particular embodiments of the invention and therefore do not limit the scope of the invention, but are presented to assist in providing a proper understanding. The drawings are not to scale (unless so stated) and are intended for use in conjunction with the explanations in the following detailed description. The present invention will hereinafter be described in conjunction with the appended drawings, wherein like numerals denote like elements, and:

**[0005]** Figure 1 is a schematic view of an exemplary medical system in which embodiments of the current invention may be incorporated;

**[0006]** Figures 2A and 2B are plan views with partial section of embodiments according to the present invention;

**[0007]** Figure 2C is an enlarged section detail from Figure 2B of one embodiment; and

**[0008]** Figure 3 is a perspective view of a portion of an alternate embodiment according to the present invention.

## DETAILED DESCRIPTION

**[0009]** The following detailed description of the invention is merely exemplary in nature and is not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the following description provides a convenient illustration for implementing exemplary embodiments of the invention. Various changes to the described embodiments may be made in the function and arrangement of the elements described herein without departing from the scope of the invention.

**[0010]** Figure 1 is a schematic view of an exemplary medical system in which embodiments of the current invention may be incorporated. Figure 1 illustrates an IMD 100 including a connector module 106 from which an

implantable lead 108 extends; implantable lead 108 includes an elongated lead body 110 including a distal portion 112 to which a pair of pace/sense electrodes 22, 24 are coupled. A proximal end of lead 108 is plugged into connector module 106 in order to couple electrodes 22, 24 to IMD 100 in a manner well known to those skilled in the art. Insulated conductors (not shown) extend within lead body 110 from electrodes 22 and 24 to a connector 107 terminating a proximal end of lead body 110, as illustrated in Figures 2A-B; the conductors couple electrodes 22 and 24 to connector ring 54 and connector pin 50, respectively.

**[0011]** Figures 2A and 2B are plan views with partial section of embodiments according to the present invention. Figures 2A-B illustrate lead connector 107 further including a first set of sealing rings 52 and a second set of sealing rings 56 adapted to provide electrical isolation and a fluid tight seal for connector 107 inserted within bore 120. Figures 2A-B further illustrate connector module 106 including a sidewall 148 forming an outer surface 118 and a connector bore 120 into which lead connector 107 is to be inserted such that a contact 125 engages connector ring 54 and a set-screw 127 in combination with a threaded connector block 129 engages connector pin 50. Contact 125 is illustrated as a multi-beam spring contact but may take any other form known to those skilled in the art. Set-screw 127 and connector block 129 form both a means of electrical engagement and a means of secure retention when engaging pin 50, wherein set-screw 127 is fastened down on pin 50 though an opening 128 in sidewall 148.

**[0012]** According to embodiments of the present invention set-screw 127 includes a flow passage 130, in fluid communication with bore 120 and outer surface 118 of sidewall 148, through which fluid pressure may be relieved when connector 107 is inserted into bore 120. As is illustrated in Figure 2B once a first set of connector sealing rings 52 becomes engaged within bore 120, air is compressed into a distal end 121 of bore 120; flow passage 130 of set-screw 127 allows the air to escape from bore, thus relieving a pressure

build up which could inhibit full insertion of connector 107. It should be noted that, in an alternate embodiment according to the present invention, connector 107 does not include sealing ring sets 52 and 56 while bore 120 includes inwardly extending sealing rings adapted to sealingly engage surfaces of connector 107 on either side of connector ring 54.

**[0013]** Figures 2A-B further illustrate a grommet seal 132 positioned over set-screw 127 to prevent fluid ingression into bore after connector 107 is fully inserted into bore 107 and IMD 100 is implanted. According to one embodiment grommet 132 is positioned, as illustrated, and bonded in place after connector 107 has been fully inserted into bore 120; according to alternate embodiments grommet 132 is bonded into position over set-screw 127 prior to insertion of connector 107. One of these alternate embodiments is illustrated in Figure 2C. Figure 2C illustrates a grommet 132′, which is adapted to open, per arrows B, in response to an internal pressure, created by connector 107 insertion (Figure 2B), that drives a fluid from bore 120 out through flow passage 130, per arrows A.

**[0014]** Figure 3 is a perspective view of a portion of another alternate embodiment according to the present invention. Figure 3 illustrates a fastening tool 10 including a handle or knob 17 and a shaft 15 extending therefrom; a distal end 16 of shaft 15 is adapted to engage an upper surface 160 of a set-screw 27, which may be interchanged with setscrew 127 illustrated in Figures 2A-2C. Set-screw 27, as shown, includes a flow passage 13 formed as a groove in an outer surface and tool 10 includes a flow passage 103, formed in an outer surface of shaft 15, which is adapted to be aligned with passage 13 of set-screw 27 when mated therewith. According to the illustrated embodiment, shaft 15 of tool 10 would be directed through a grommet seal, i.e. grommet 132 (Figures 2A-B), to engage set-screw 27 prior to connector insertion, thus, during connector insertion, flow passages 13 and 103 provide fluid communication between bore 120 and outer surface 118 in order to vent bore 120. After connector 107 is fully inserted into bore 120,

tool 17 is rotated to fasten screw 27 down on pin 50 and removed back through grommet 132, which maintains a fluid tight seal thereafter.

**[0015]** While specific embodiments have been presented in the foregoing detailed description of the invention, it should be clear that a vast number of variations exist. It should also be appreciated that the exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road-map for implementing an exemplary embodiment of the invention. It should be understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiments without departing from the scope of the invention as set forth in the appended claims.